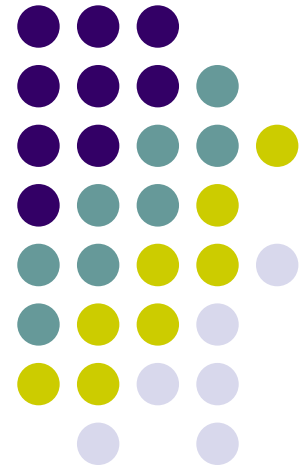




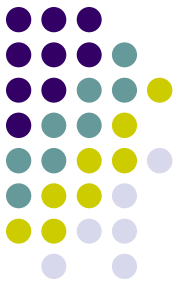
Mission Critical Commissioning for Healthcare Facilities

Steven (Rusty) Ross, PE
SSRCx, LLC

April 2008



Mission Critical Systems and Tasks



- **Systems**
 - Mechanical
 - Electrical
 - Plumbing, Fire Protection, Other
- **Tasks**
 - Pre-Design and Design Phase
 - Construction Phase
 - Acceptance Phase
 - Post Occupancy Phase



Mechanical Systems



- **Critical systems:**
 - **Chilled water systems**
 - **Steam and Heating Systems**
 - **Airside systems**
 - **HVAC controls**
 - **Systems Integration**



Chilled Water Systems



- **Components**
 - **Chillers**
 - **Cooling towers**
 - **Pumping systems**
 - **Plate and frame heat exchangers**
 - **Make-up water systems**
 - **Chemical treatment systems**

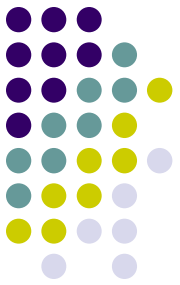


Chilled Water Systems



- **Critical – temperature control and Dehumidification**
- **One of the greatest impacts on energy bill**
- **Must efficiently provide required CHW flow and temperature**





Chilled Water Systems

- **Critical – functional testing must address central plant functions and load side conditions**
- **Satisfy the dynamic nature of loads served**
- **Off-peak system efficiency**
- **Chillers operate most efficiently when fully loaded**
- **Most systems operate more chillers than load should require**



Steam and Heating Systems



- **Critical - humidification, heating, process/sterilization**
- **Steam boilers or a combination of steam and heating hot water boilers**
- **Must be on emergency power at all times**
- **Stand-by Capability must function automatically**
- **Variable load for heating, dehumidification, sterilization and sometimes domestic hot water**



Steam and Heating Systems



- **Components:**
 - **Boilers**
 - **Make-up systems**
 - **Fuel oil systems**
 - **Pressure reducing stations**
 - **Heat exchangers**
 - **Pumping systems**
 - **Steam condensate return systems**
 - **Humidifiers**



Steam and Heating Systems



- **Must satisfy dynamic load conditions**
- **Hot water boilers served by primary/secondary pumping system**
- **Steam to water heat exchangers with variable flow**
- **Energy efficient controls**
 - **OAT reset schedule**



Air Side Systems



- **Must meet critical needs:**
 - **Temperature control**
 - **Air Changes/Outside air requirements**
 - **Humidification**
 - **Space pressurization**
 - **Overall building pressurization**
 - **Special**
 - **Heart/Ortho**
 - **Isolation systems**
 - **Life safety**



Air Side Systems



- **Systems include:**
 - **Air handling units**
 - **Return/relief fans**
 - **Make-up air systems**
 - **Exhaust fans**
 - **Filtration**
 - **Local zone controls**
 - **Humidifiers**
 - **Smoke evacuation systems**
 - **Stair pressurization systems**



Air Side Systems



- **Operation scenarios:**
 - Normal power operation
 - Transfer to and from emergency power
 - Operating on emergency power
 - Peak load conditions
 - Varying load conditions
 - Alarm modes
 - Stand-by/Redundant modes
 - Night set-back modes
 - Override conditions



Systems Integration



- **Dynamic system integration**
 - **Air Handling Units/ Return systems**
 - **Fan Tracking**
 - **Terminal boxes/Air valves**
 - **Humidifiers**
 - **Exhaust systems**



HVAC Control System

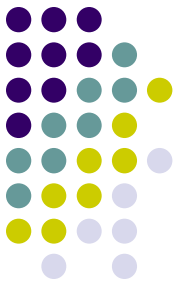


- **Controls all components**
- **Critical for function and energy efficiency.**
- **Maximize capabilities of building operator**
- **Must be calibrated, points mapped, alarms programmed, communications functioning properly.**

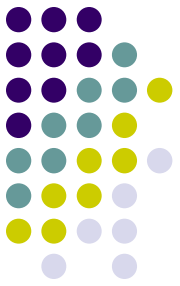


HVAC Control System

- **Device locations**
- **System Integration**
- **Communication to operators**
- **Alarms and Critical conditions**



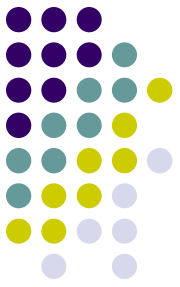
Electrical Systems



- **Critical Systems**
 - **Unit subs/main electrical switchgear/distribution level switchgear**
 - **Essential electrical system**
 - **Fire alarm system**
 - **Nurse call system**



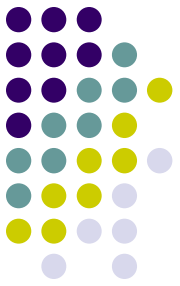
Main Switchgear/Unit Subs/ Distribution Switchgear



- **Core elements of the normal power electrical distribution system:**
 - Main switchgear
 - Unit subs
 - Distribution level switchgear
- **Must be installed correctly**
- **Coordination Study**



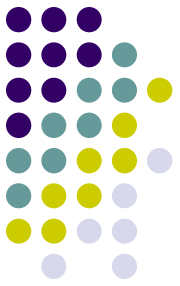
Main Switchgear/Unit Subs/ Distribution Switchgear



- **Manual or automatic “throw-over” schemes, kirk-key arrangements, etc.**
- **Monitoring Systems**
 - **SCADA**
 - **Building management system**



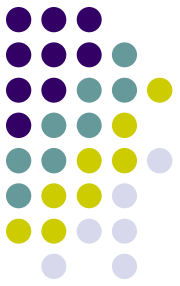
Essential System



- **Most critical electrical distribution system**
- **Essential system consists of two systems:**
 - **Emergency system**
 - Life safety branch
 - Critical branch
 - **Equipment systems**
- **Independent**



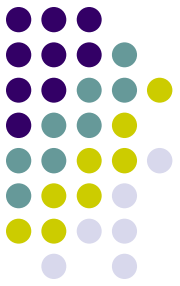
Essential System



- **All gensets/switchgear must be Cx'd**
 - Paralleling switchgear
 - Transfer switches
 - Distribution level switchgear
- **Functions/Sequences:**
 - Switchgear operations
 - Priority loads and load shed schemes
 - Interface with fuel oil system
 - Remote alarms/annunciation
 - Transfer/delay/cool down modes

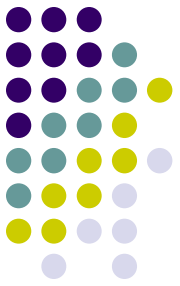


Essential System



- **Electrical system testing versus testing the loads**
- **The essential system must be tested with all connected loads operating and under control**
- **Critical – loads are properly configured**



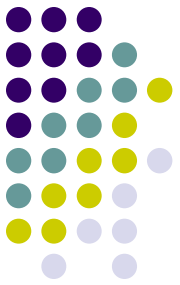


Fire Alarm System

- **Critical to life safety of the staff and patients.**
- **Interfaces with multiple systems including:**
 - HVAC control system
 - Elevators
 - Security systems
 - Fire protection system
 - Doors
 - Paging system
 - Specialty system such as smoke evacuation
 - Stair pressurization systems
 - Kitchen equipment



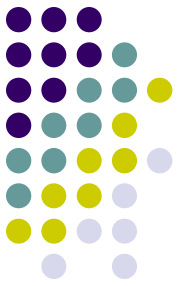
Nurse Call/Code Blue System



- **Critical communication between patients and staff**
 - **Code blue system – Critical communication among the staff.**
 - **Nurse Call – Communication from patients to staff.**



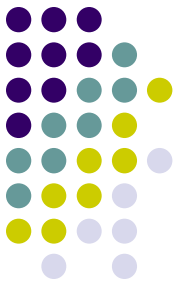
Plumbing & Fire Protection Systems



- **Systems most critical in hospitals:**
 - Domestic hot water
 - Cold water systems
 - Fire protection systems
- **Medical gas is critical - Independent certification**



Domestic Hot and Cold Water Systems

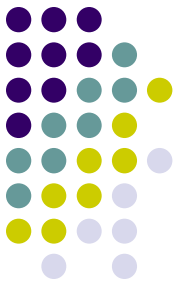


- **Water supply is critical.**
 - **Booster pumps**
 - **Water softeners**
 - **Domestic heating systems**

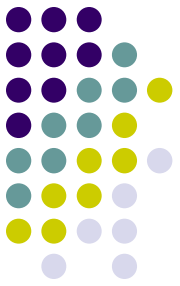


Fire Protection System

- Fire pump
- Jockey pump
- Automatic sprinkler system
- Pre-action systems
- Dry systems



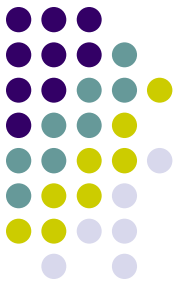
Mission Critical Commissioning Tasks



- **Tremendous effort has been made to develop commissioning standards.**
- **The following define standards for commissioning:**
 - **BCA/PECI**
 - **ASHRAE**
 - **USGBC**
 - **ACG, NEBB, SMACNA, Others**



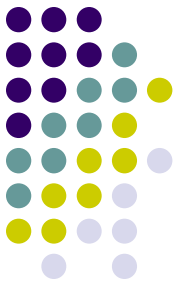
Mission Critical Commissioning Tasks



- **Commissioning is delivered over the course of the project.**
- **Phases:**
 - **Pre-design**
 - **Design**
 - **Construction**
 - **Acceptance**
 - **Post-occupancy**



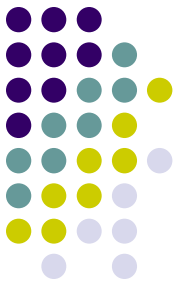
Pre-Design & Design Phase Tasks



- **Critical Tasks:**
 - **Development and review of the Owner's Project Requirements (OPR)**
 - **Commissioning specifications**
 - **Plan reviews:**
 - **SD level**
 - **DD level**
 - **CD level**



Owner's Project Requirements



- **Describes in measurable terms the Owner's expectations**
- **Defines:**
 - **Efficiency/Sustainability goals**
 - **Owner and user requirements**
 - **Indoor Environmental Requirements**
 - **Equipment/System expectations**
 - **O&M requirements**
- **Develop prior to design phase**
- **Programming document for Systems**



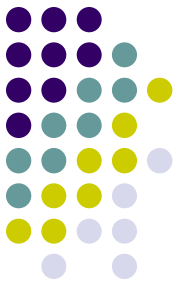


Plan Reviews

- **Most cost effective/proactive Cx activity**
- **Input prior to finalizing bids**
- **This feedback identifies:**
 - **Conflicts**
 - **Coordination between disciplines**
 - **Maintainability**
 - **Clarity for Control sequences**
 - **System integration**



Commissioning Specifications



- **Contract documents must incorporate the Commissioning scope**
 - **Roles/Responsibilities**
 - **Tasks**
 - **Systems**
 - **Sample Checklists, Test procedures**



Construction Phase Tasks



- **Critical Tasks:**
 - **Commissioning plan**
 - **Project specific checklists and FPTs**
 - **Cx process - Manage and Coordinate**
 - **Updates - Revisions to scope/shops**
 - **Installation of work must be confirmed**
 - **Start-up – monitor the planning and execution of the process**



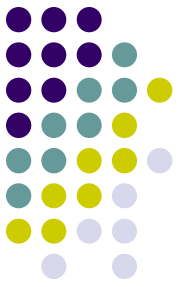
Commissioning Plan



- **Cx Plan:**
 - **Define commissioning process**
 - **Identify critical milestones**
 - **Identify deliverables**



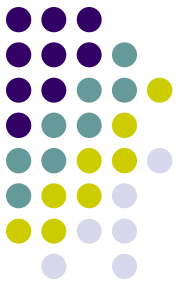
Installation Checklists and Functional Performance Test Procedures



- **Installation/Pre-functional checklists:**
 - Project specific
 - Reference contract documents requirements
 - Documents installed per contract documents
- **Functional test procedures**
 - Project specific
 - Reference contract documents requirements
 - Integrated system functional requirements

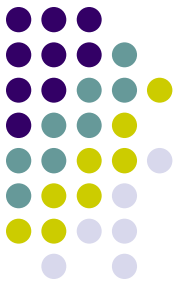


Construction Phase Field Activities



- **Cx plan should be a roadmap**
- **Process should be proactive/integrated into the master project schedule**
- **Site visits**
 - Document installation
 - Meetings – as necessary
 - O&Ms
 - Plan to prepare the operations staff





Acceptance Phase Tasks

- **Installation, Start-up, Test and Balance must be complete prior to Acceptance Phase**
- **Critical Tasks**
 - **Functional testing**
 - **Owner training and other required documentation**
 - **Final commissioning report**

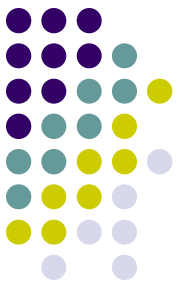


Functional Performance Testing



- **Testing sequence must be defined**
 - **How do systems serve facility**
 - **Construction Master schedule**
- **Testing occurs as systems are completed**
- **Integrated functional testing plan**
- **FPTs must be complete prior to final functional reviews by the code authorities**



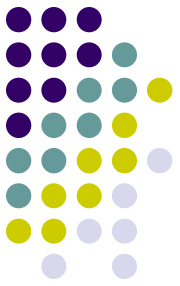


Final Documentation

- **Provide operators all documentation so they can plan to operate the facility**
 - **Provide before Acceptance Phase**
 - O&Ms
 - Systems Manual
 - Record Documents
 - **Commissioning Final Report**
 - As soon as possible after functional testing



Post Occupancy Phase Tasks



- **Critical Tasks**

- **Opposed season systems testing**
 - Economizers
 - Humidifiers
- **Peak load conditions**
 - Summer
 - Winter



Thank You!

Steven (Rusty) Ross, PE

rross@ssr-inc.com

615. 383. 1113

